

DOCUMENT OF THE INTER-AMERICAN DEVELOPMENT BANK

## **CHILE**

# **HYDROLOGICAL MODELING AND POLLUTION CONTROL STUDY OF THE CONCEPCIÓN AND SAN VICENTE BAYS**

**(TC-01-01-03-8-CH)**

## **PLAN OF OPERATIONS**

This document was prepared by the project team consisting of: Antonio Carlos Rossin, Project Team Leader (RE1/EN1); Adriana Delgado (RE1/EN1); Francisco Javier Lois (COF/CCH); Emilio Cueto (LEG/OPR); Luiz Penna Franca (consultant); and Alicia Maldonado, Project Assistant (RE1/EN1); assisted in the production of the document.

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## **ABBREVIATIONS**

BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
CONAMA	National Environment Commission
DO	Dissolved oxygen
ESSBIO	Empresa de Servicios Sanitarios del Bio-Bio (Bio-Bio regional water company)
PRAT	Talcahuano Environmental Recovery Program

# HYDROLOGICAL MODELING AND POLLUTION CONTROL STUDY OF THE CONCEPCIÓN AND SAN VICENTE BAYS

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## EXECUTIVE SUMMARY

<b>Requester/ Beneficiary:</b>	Republic of Chile, acting through the National Environment Commission (CONAMA).		
<b>Amount and source:</b>	IDB: (Japanese Trust Fund for Consulting Services)	US\$ 1,200,000	
	Local counterpart:	<u>US\$ 240,000</u>	
	Total:	US\$ 1,440,000	
<b>Terms and conditions:</b>	Nonreimbursable Technical-Cooperation Fund		
<b>Execution timetable:</b>	Execution period:	18 months	
	Disbursement period	20 months	
<b>Objectives:</b>	Development, setup and transfer of a mathematical model to simulate the hydrodynamic behavior of current-dispersion and water quality in the bays of Concepción and San Vicente; and preparation of a pollution control plan to provide an optimal framework for reducing pollution in the two bays.		
<b>Description:</b>	In keeping with its hiring policy, the Bank will contract a Japanese consulting firm to execute this operation, using JCF funds. The consulting firm contracted will carry out the following activities: (i) development of the simulation model; (ii) preparation of the pollution control plan; and (iii) technology transfer and training. The various components will be implemented concurrently as a whole during the different stages and activities planned. The National Environment Council (CONAMA) will use the local counterpart funding to hire consulting services for the development of a program to monitor water quality in the two bays.		
<b>The Bank's country strategy:</b>	This operation is consistent with the Bank's strategy for Chile since it provides tools to enable government bodies to improve environmental quality and life in one of the country's major urban areas, through public and private-sector partnerships applying established technology.		

<b>Environmental and social review:</b>	<p>The final product of this operation will be an action plan for cleaning up the current polluted state of the Concepción and San Vicente bays. Implementation of this plan will have a wide-ranging, significant and positive impact on water and environmental resources in the Concepción/Talcahuano metropolitan area.</p> <p>The Committee on Environment and Social Impact (CESI) reviewed and approved this operation on 22 March 2002.</p>
<b>Benefits and beneficiaries:</b>	<p>Benefits: Development of operational tools for effective control of water pollution in the two bays, in accordance with the action plan proposed by the Talcahuano Environmental Recovery Program.</p> <p>Direct beneficiaries: CONAMA, the municipality of Talcahuano, firms in the region, and people living in the Talcahuano and Concepción community.</p>
<b>Risks:</b>	<p>Project risk lies in the technology transfer and training component. If its activities fail to achieve their objectives, the viability of the control plan resulting from the project could be jeopardized. Mitigation of this risk is addressed in the operation through strengthening of the training activities and the execution mechanism, involving broad-based participation by several institutions and local experts in the project coordination and execution structure.</p>
<b>Special contractual clauses:</b>	<p>CONAMA will use local counterpart funding to hire a local consultant to implement the program to monitor water quality in the bay by mutual agreement with the international consulting firm and the Bank (paragraph 3.42).</p>
<b>Exceptions to Bank policy:</b>	<p>No requests for exceptions to Bank policies will be made.</p>

## **I. BACKGROUND**

### **A. Environmental situation in the region**

- 1.1 Talcahuano is one of the 11 municipalities comprising the province of Concepción, located in Chile's 8th region, also known as the Bio-Bio region. A large part of its territory is bounded by water bodies, both marine and freshwater. Within these natural limits, there are three very important systems: San Vicente Bay in the western sector, Concepción or Talcahuano Bay in the north, and the Bio-Bio river, which gives its name to the region, in the southern sector.
- 1.2 Talcahuano began to develop into an industrialized city after the Huachipato iron and steel works started operations in 1946. This is a subsidiary of Compañía de Acero del Pacífico (CAP) and was the first iron and steel plant established in Chile. Within a short time many other firms with links to the iron and steel and petrochemical sector had established themselves in the area, and today it is home to over 600 medium-sized and small industrial enterprises and 40 large-scale industries engaging in a very wide range of productive activities.
- 1.3 The municipality's two ports, located in the two bays, handle 25% of Chile's total port cargo. The area is also rich in marine resources, and is considered one of the most productive marine regions of the world. Nonetheless, these resources and this potential are being undermined by negative externalities arising from productive activities, which degrade the region's natural resources and impair the quality of life of its inhabitants.
- 1.4 The municipality currently supports a variety of natural systems, including salt marshes, rocky shorelines and humid forest remnants. These coexist with Chile's heavy industrial base, including the iron and steel/metal engineering complex (Compañía Siderúrgica Huachipato and other firms in the sector), a petrochemical complex (Refinería Petrox and others); together with shipbuilding yards, fishing and industrial terminals; industrial and small-scale fishing activity; a fishmeal processing industry, which constitutes the country's most important industrial fishery complex; and a very wide range of other small and medium-sized businesses. In addition, the Chilean navy has a base at Talcahuano, which occupies 35% of the municipality's limited land area.
- 1.5 The population of the municipality is estimated at 280,000 inhabitants, who compete with industry for scarce living space.
- 1.6 Port activity in the port of San Vicente, coupled with discharges of industrial and domestic waste and non-point effluents of urban origin from the city of Talcahuano, contributes to the degradation of water quality in the two bays (Annex I shows the level of wastewater discharged into the bays). The environmental deterioration caused by urban and industrial activity in the municipality of Talcahuano has



become so bad that the local inhabitants and the country at large view Talcahuano as Chile's most polluted city, and the one with the worst quality of life.

- 1.7 Problems of environmental deterioration in Concepción Bay are more critical in the southeastern sector where the highest impact activities are concentrated: i.e. the commercial port of Talcahuano, effluents from the fishing industry and a small-scale fish terminal. The situation in the port zone and adjacent sectors is critical, since they are very close to the city's civic center, which seriously damages its urban image. From this area, the main source of impact, a pollution dispersion gradient runs out towards the extremities of the bay.
- 1.8 San Vicente Bay has multiple uses, with a variety of activities coexisting in generally unfavorable conditions. Activities include a commercial port, an industrial complex including steel and metal engineering activities, chemicals, petrochemicals and fisheries, among others; a non-industrial fishing port; small-scale shipbuilding yards, and an oil terminal, alongside shellfish banks that are exploited on a non-industrial basis, and areas of aquaculture.
- 1.9 Water quality problems are most critical around the fishing port, where environmental changes have reached a well-nigh unrecoverable phase, at least in terms of seabed sediments. In adverse weather conditions (north wind) this situation can have a major impact on the rest of the bay. Bacteriological pollution is critical both in the port area and in the wastewater effluent zone. Hydrocarbons contained in the sediments register high concentrations throughout the San Vicente port sector. Trace metals (Cd, Cu, Pb and Zn) found in the sediments generally register a higher concentration in the fishing port sector.

## **B. Legal and institutional aspects**

- 1.10 Chile's Environment Act (Law 19.300, Ley de Bases de Medio Ambiente) passed in 1994, created the National Environment Commission (CONAMA), laid the foundations for protecting natural resources, and gave incentives for drafting and implementing pollution prevention and control plans.
- 1.11 CONAMA is the government body responsible for ensuring environmental sustainability in the development process, and for coordinating actions arising from government environmental policies and strategies. Its basic objectives are as follows: (i) to restore and improve environmental quality; (ii) to prevent environmental deterioration; (iii) to promote the protection of the country's environmental assets and encourage sustainable use of natural resources; (iv) to introduce environmental criteria in production sectors; (v) to involve the general public in environmental management; (vi) to strengthen environmental institutions nationally and at the regional level; and (vii) to improve environmental legislation and develop new management tools. CONAMA is geographically deconcentrated and operates through regional offices that act as the commission's voice in each

region. Nationwide it employs approximately 500 staff, including professionals, technical experts, administrative workers and auxiliary staff. At the regional level, CONAMA's Bio-Bio office has 21 professional staff, one technical expert and four administrative staff.

### **C. The Environmental Recovery Plan**

- 1.12 Given the situation of extreme environmental deterioration in the Talcahuano municipality, since 1994 CONAMA has been coordinating the Talcahuano Environmental Recovery Program (PRAT), and lobbying to achieve consensus on the need to reverse the municipality's deteriorated environmental state. Since its inception, the design of this program has prioritized environmental restoration in the municipality through cooperation and working agreements. The PRAT has set up a formal planning and participatory management process involving regional and municipal authorities, public and private enterprise, union organizations, trade and professional associations, the organized community, non-governmental organizations and academics. The project has received mixed public-private funding with contributions from CONAMA, the municipality of Talcahuano, and leading firms in the area.
- 1.13 During the first stage of the program, a diagnostic study was prepared that identified the environmental problems existing in the municipality, in air, water and soil, together with conflicts involving resource use and quality of life. The document outlined projects aimed at solving these problems, which included the need to characterize and improve water quality in the Concepción and San Vicente bays, which naturally involved both the public and the private sector.
- 1.14 Once the diagnostic was complete and the lines of action established, efforts turned to executing the commitments made by the various sectors of the community. Priority has been given to a strategy of agreement protocols that seek to make the most of the activities and projects implemented.
- 1.15 At the present time, the PRAT includes a total of 51 projects, which are being executed in four specific areas: land management; conservation and management of natural resources; environmental and health management; environmental education and citizen participation. The projects are moving ahead at different rates according to the investment capacity of the sectors involved. The total investment made during 1994-2000 by the private sector in fulfilling commitments assumed, was approximately US\$516 million.
- 1.16 Projects and actions to reduce water pollution, either already implemented or ongoing, include the following: improvements to the municipal wastewater treatment and disposal system by the Bio-Bio regional water company (ESSBIO); studies to characterize sediment pollution in San Vicente Bay; feasibility studies for handling liquid industrial wastes in Chile's 8th Region (Talcahuano); programs to

monitor water quality in the Concepción and San Vicente bays; projects executed by fishing industries to improve catchment landing systems; improved processing technologies in the iron and steel/metal engineering sector which resulted in a reduction in the discharge of heavy metals and other compounds; implementation of a treatment plant for bilge waters and contaminated hydrocarbons in the shipbuilding sector.

- 1.17 These isolated actions together have not been enough to reduce the risks of permanent impact on the region's natural resources and economic development. A comprehensive plan to control water pollution needs to be developed and implemented to provide a definitive solution to the problem.
- 1.18 To achieve these objectives, CONAMA will need to develop a simulation model of the hydrodynamic behavior and quality of the water in the two bays, in order to assess the marine system's capacity to assimilate the multiple sources of wastewater and industrial effluents acting on it.
- 1.19 This technical cooperation project is consistent with recommendations for drawing up a pollution control plan for both bays made in the initial stage of the current PRAT by the Technological Research Institute (INTEC), the European/Latin American Center for Research and Training in the Environmental Sciences of the University of Concepción (EULA), and CONAMA.

## **II. OBJECTIVES**

- 2.1 The objective of this operation is to design a tool to simulate the dynamic behavior and quality of the water in the Concepción and San Vicente bays, using a validated mathematical model to define the load capacity of the water bodies in question (assimilation capacity), and evaluate the changes produced in the environment as result of applying different measures for controlling wastewater under hypothetical scenarios. As an integral component of the studies in the area, a pollution control plan will be prepared, focusing on the discharge of wastewater and liquid industrial residues.
- 2.2 The project will be implemented as a comprehensive technical collaboration including the transfer of technology and experience in the field of hydrodynamics and water quality modeling; monitoring and evaluation; together with clean-up and improvement of industrial and domestic wastewater disposal facilities.
- 2.3 The specific objectives of the technical cooperation (TC) are as follows:
  - a. To establish, transfer and set up a three dimensional dynamic (time variable) mathematical model giving details of: hydrodynamics, currents and dispersion, and water quality in the two bays.

- b. To investigate the load capacity of the bays, by using the mathematical model calibrated and validated to simulate different alternatives for the treatment and discharge of industrial and domestic effluents into the bays.
- c. To prepare a pollution control plan aimed at optimal pollution reduction in the two bays, in compliance with current Chilean environmental regulations.
- d. To train CONAMA staff, and professionals from other institutions involved in the project, for technology transfer in using the model as an environmental management tool in the two bays.

### **III. DESCRIPTION OF THE PROJECT**

#### **A. Components and stages**

- 3.1 The operation is divided into three components: (i) development of the simulation model; (ii) preparation of the pollution control plan; and (iii) technology transfer and training. The components will be executed in concurrent and integrated fashion throughout the planned stages and activities.
- 3.2 The project will be implemented in two phases with four stages each. Stage 1 is an initial stage to develop the detailed work plan. Stages 2, 3, and 4 correspond to the three main project components. The modeling strategy requires the project to be developed in two phases (see timetable).
- 3.3 The design of the first component (development of the simulation model) took account of current knowledge of the oceanographic dynamics of the Bio-Bio region, which displays marked seasonality in local meteorological and oceanographic conditions. There are two periods of approximately uniform conditions, corresponding to winter (the months of June and July) and summer (the months of December, January and February). The intervening months represent a transition situation. The modeling strategy adopted for this component will choose the most critical oceanographic and meteorological conditions for processes affecting water quality in the two bays, for both typical periods. There will be two campaign periods for field measurement, monitoring of water-quality parameters, and sampling of wastewater effluent sources, corresponding to the periods selected for the simulation. Data from the first campaign period will be used to calibrate the models for the two bays. Data from the second period will be used to validate the models.
- 3.4 The component to design the pollution control plan will be carried out on the basis of the existing diagnostic study of polluting industries in the area, which will be complemented further. The simulation to be run in component 1, using the water quality model for the bays, will make it possible to define the stages needed for industries to adapt their discharges to standards to be set by CONAMA.

- 3.5 The technology transfer and training component will be implemented through activities such as seminars, presentations and on-the-job-training.

**B. Implementation**

- 3.6 The Bank will use JCF funds to select and hire a consulting firm specialized in developing, adapting and implementing the mathematical hydrodynamic water-quality model. The contracted firm will use this tool to prepare a pollution control plan for the Concepción and San Vicente bays. CONAMA will use counterpart funds to obtain data on water quality in the two bays, which are needed for preparing and calibrating the model.
- 3.7 Implementation will take place in two phases. In phase I, corresponding to the first ten months of the timetable, the detailed planning stage of the work plan will be prepared (stage 1), after which work will begin on developing the model as such (stage 2); this will culminate in its calibration. Work to develop the pollution control plan (stage 3), can be started after completion of one-third of stage 2. At the end of phase I, the model will have been calibrated and the preliminary version of the control plan will be ready. Technology transfer and training activities (stage 4), will take place throughout phase I, with concentrated periods to hold programmed events (courses, seminars and workshops).
- 3.8 In phase II, stages 2 and 3 will run continuously, with validation of the model after the second campaign program has been held, together with review and finalization of the pollution control plan. Stage 4 will also be continuous.
- 3.9 Given the seasonal nature of oceanographic conditions, the ideal date for starting the project is the month of August, with the possibility of extending it until October. Alternatively, the project could be started in the March-May period. The ideal timetable for the TC project, assuming an August start, is presented below, and a detailed project timetable is provided in Annex II.

### Execution timetable

STAGES	Months																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	PHASE I										PHASE II							
1. Definition of definitive work plan		+	+															
2. Development of simulation model																		
Calibration						+	+											
Validation												+	+	+		PF		
3. Development of control plan																		
Preliminary version										+								
Final version																+	PF	
4. Technology transfer and training		T,S	T	T	T	T	T		T	T,S				T		T	S	

Delivery of products: (+) interim (PF) final  
Activities: (T) Workshop (S) Seminar

3.10 The activities to be carried out in each phase and stage of the project are described below.

#### a. Phase I

##### (i) Stage 1 – Definition of detailed work plan

3.11 The detailed work plan for executing the operation will be prepared after the start of the project. The preliminary version of the work plan will be prepared beforehand in order to make the key points of the plan available for discussion with CONAMA and regional experts.

3.12 This stage will require the following activities: collection of background information; preparation of preliminary work plan; presentations and discussion of preliminary work plan; preparation of detailed work plan. The detailed plan will take account of contributions made in discussions of the preliminary plan in the work seminar.

##### (ii) Stage 2 – Development of the model

3.13 Development of the model in phase I will include the following tasks:

- Collection, systematization, evaluation and storage of existing data relevant to the study. The database will include the following, among other things: bathymetrics, hydrography, oceanographic conditions, meteorology, currents and dispersion, data on water quality and sediment pollution, and on the

ecological status of the bays.

- b. Establishment of baseline documentation using available information;
- c. Review of current environmental regulations in Chile relevant to the project;
- d. Selection and specification of models;
- e. Planning of field measurement and additional monitoring to calibrate and validate the model;
- f. Identification and location of all pollution sources relevant for model calibration;
- g. Evaluation of existing data characterizing pollution sources, and design of additional sampling program;
- h. Execution of program of field measurement, monitoring and sampling of additional sources;
- i. Preparation of data sets for calibration;
- j. Calibration of model; and
- k. Preparation of user manuals and reference handbooks for the model.

**(iii) Stage 3 – Pollution control plan – preliminary version**

- 3.14 Development of the pollution control plan in phase I will include the following tasks:
  - a. Collection of research data on pollution sources;
- 3.15 This will involve visiting public and private bodies responsible for, or associated with the control and regulation of pollution sources, in order to obtain data characterizing each relevant source of discharge into the two bays. The following information will be collected: quantitative data on discharges of industrial and urban wastewater; existing plans and projects for wastewater treatment and disposal; regulations on the protection of coastal water quality, control of industrial wastewater and disposal of urban effluents. Non-point urban effluent loads will be estimated together with agricultural discharges entering the bays, if significant.
  - b. Simulation of the current situation and load capacity of the bays.
- 3.16 A series of simulations of conditions in the two bays will be run using the models developed. These will start as soon as calibrated models are available. Following the validation period, two types of simulations will be reviewed:

(i) Simulations of current situation

- 3.17 These correspond to results of the model using current data on discharge levels and the most critical meteorological and oceanographic conditions in terms of water quality.

(ii) Simulations of load capacity

- 3.18 These correspond to results of the model simulating wastewater discharges at a series of strategically located points, in order to investigate the maximum capacity of the bays to assimilate effluents from point- and non-point sources, whether urban or industrial, current or future.
- 3.19 Load capacity will be determined on the basis of environmental quality and protection targets to be proposed for the different sectors of the bays.
- 3.20 Chilean regulations, which are in the final phase of discussion and approval (final draft of Quality Standards for the Protection of Marine Waters), establish different types of quality target, according to current, potential or future intended uses. In each case the quality target has to be set by CONAMA. The simulations to be run in the TC project will serve as an input for the discussion of environmental quality and protection targets to be set by CONAMA, taking into account the two bays' multiple uses. During this stage of the project, one or several alternative quality targets will be proposed for inclusion in the simulations.

c. Analysis of pollution control alternatives.

- 3.21 Research will be carried out to identify the treatment schemes and urban and industrial wastewater discharge levels that seem most viable, for each quality target proposed. There will also be research into the different treatment and discharge alternatives, including the following:
- (i) Methods and level of treatment needed for each discharge; and
  - (ii) Alternative treatment or discharge solutions will be studied, including the following: collective treatment of industrial wastewaters at certain plants or industries, as compared to separate treatment in certain plants; discharge of industrial wastewater from specific sources into the public sewerage system and treatment in urban wastewater treatment plants; location of wastewater treatment plants; collection of wastewater (sewerage network, pumping stations); methods for disposal of effluents (including, in appropriate cases, types of discharge in the sea - underwater emission).
- 3.22 This exercise will make it possible to develop one or more least-cost schemes for wastewater treatment and discharge for each quality target proposal. The simulation



models will be used at this stage to verify compliance with the quality targets. The solution considered optimal for the collection, treatment and final disposal of discharges will be chosen on the basis of evaluation criteria that will be made fully explicit.

- 3.23 This activity will involve intensive consultation with the main stakeholders (municipalities, sanitation companies, fishery companies and industries, university experts and others). Preliminary results will be provided in an interim report and discussed at a working seminar.

**(iv) Stage 4 – Technology transfer and training**

- 3.24 In general terms, training will include the following:
- a. Training of CONAMA staff;
  - b. Training (including on-the-job) during the data planning and evaluation stage;
  - c. Training and hands-on practice during field measurement;
  - d. Training and hands-on practice during transfer of the model;
  - e. Training course on water quality models; and
  - f. Training course on three-dimensional hydrodynamic modeling.
- 3.25 CONAMA will hold technical working seminars to present and discuss the main concepts and decisions to be taken at each stage of the TC project. The main stakeholders in the region, already involved in implementation of the PRAT will be invited to participate in meetings, seminars and other events to be scheduled by CONAMA. This participation dynamic will contribute to the process of negotiating and implementing the plan.
- 3.26 The preliminary scheduling of events will include the following seminars in phase I at least:
- a. Seminar 1 - Presentation and discussion of the TC work plan; and
  - b. Seminar 2 - Presentation and discussion of water pollution control alternatives.
- 3.27 CONAMA will program workshops with participation from the Chilean counterpart and the international consultants; these will be held during the course of the project to discuss and analyze its most important activities.
- 3.28 Workshops to be held in phase I will include the following:

- a. Workshop 1 - Preparation of monitoring program;
- b. Workshop 2 - Preparation of monitoring campaigns;
- c. Workshop 3 - Setting up of the model;
- d. Workshop 4 - Analysis of discharge data;
- e. Workshop 5 - Analysis of data gathered from monitoring/calibration campaigns;
- f. Workshop 6 - Analysis of model simulations;
- g. Workshop 7 - Analysis of Control Plan - Preliminary Version.

**b. Phase II**

**(i) Stage 2 – Development of simulation model – validation**

- 3.29 Preparation of the model will be finalized on completion of the second part of the program of field measurement, monitoring and sampling of additional sources, followed by model validation. The resulting model will be delivered to CONAMA.

**(ii) Stage 3 – Pollution control plan – final version**

- 3.30 The definitive version of the pollution control plan will be prepared following final validation of the models for the two bays. Revisions will be made of previous simulations, the minimum cost schemes and the optimal solution, to take account of any alterations made during the validation stage. In addition to results from previous stages, the plan will include the following elements:
- a. Conceptual design and cost estimate.
- 3.31 The plan will include the conceptual design of installations in each of the project components; these will include, in general, preliminary estimates of the cost of construction, management and maintenance of the recommended installations.
- b. Plan for implementing the pollution control plan (Action Plan).
- 3.32 A strategy or action plan will be proposed for implementing the pollution control plan, indicating project components, their respective cost, the timetable for implementing the various components, and the agencies or companies that will share responsibility for implementation. The preliminary financial analysis of the plan will be prepared, and the government body or institution responsible for its implementation and monitoring will be analyzed and recommended.

- 3.33 The final product in the pollution control plan component will be delivered to CONAMA.

**(iii) Stage 4 – Technology transfer and training**

- 3.34 Training (including on-the-job), will be programmed continuously during the activities to validate and transfer the model, and during preparation of the pollution control action plan.
- 3.35 Preliminary programming of events in phase II will include at least the following workshops and seminars:
- a. Workshop 8 - Model validation;
  - b. Workshop 9 - Analysis of control plan - final version;
  - c. Seminar 3 - Presentation of water pollution control plan - final.

**C. Beneficiary agencies and other participating institutions**

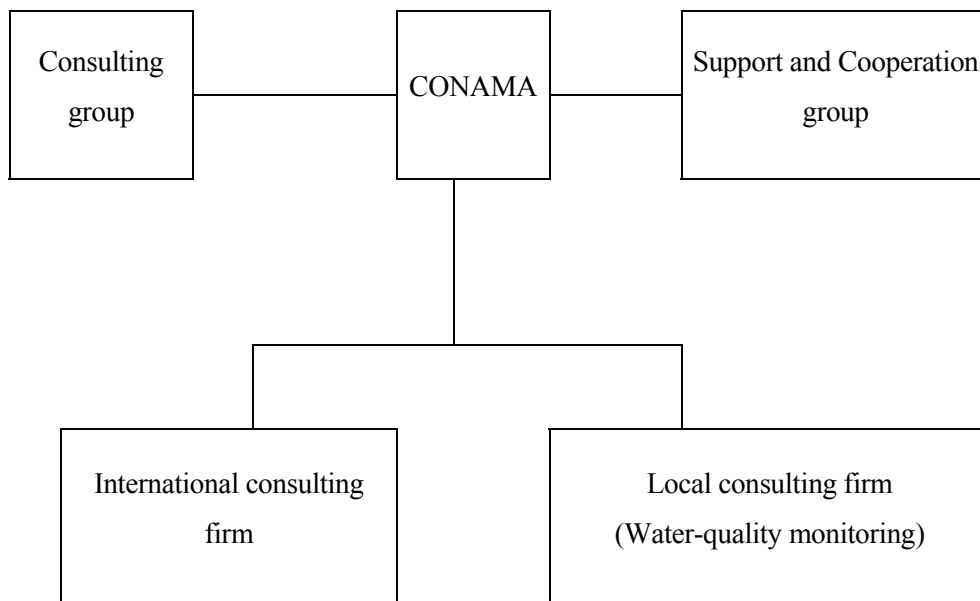
- 3.36 The beneficiary of this operation will be CONAMA acting through its Bio-Bio regional office, in coordination with the executive board. CONAMA is a public institution with a mission to promote environmental sustainability in development and to coordinate the government's environmental policy actions and strategies. CONAMA operates in decentralized fashion throughout Chile. There are regional CONAMA offices in each administrative region presided by a regional governorship.
- 3.37 CONAMA participation in this project will involve coordinating the various regional actors, in participatory fashion, following the example of the coordination activity it has been leading in the PRAT. On the specific issues of hydrodynamic modeling and water quality, CONAMA will be supported by experts from local centers of research excellence in this area, namely the European/Latin American Center for Research and Training in the Environmental Sciences of the University of Concepción (EULA), and the Department of Environmental Chemistry in the Science Faculty of Universidad Católica de la Santísima Concepción (UCSC).

**D. Execution mechanism**

- 3.38 The operation will use CONAMA as the focal point for coordinating project execution, with supervision from the specialist at the Bank's Country Office in Chile, and from headquarters. CONAMA will engage a number of other institutions and local consultants throughout the project, depending on the demand for specialized human resources to carry out counterpart activities.

- 3.39 The project visualizes hiring a Japanese consulting firm to provide services using international and local staff, for up to US\$1.2 million; this will cover travel and per diem expenses, together with administration, materials and services.
- 3.40 The Bank will engage the consulting firm through a consultancy contract. The Country Office in Chile will be responsible for managing the operation and authorizing payments to the consulting firm, subject to prior technical review by EN1. The beneficiary organization will carry out the technical review and submit a report containing opinions and recommendations on the quality of the reports presented by the consulting firm.
- 3.41 The organization chart of project coordination team is shown below:

**ORGANIZATIONAL CHART FOR EXECUTION OF THE OPERATION**



Corresponding to:

- 3.42 **National Environment Commission (CONAMA):** CONAMA Bio-Bio will carry out general coordination of the TC project and will be responsible for the actions of the national counterpart. Counterpart activities will include the following: liaison with local institutions; organization and execution of technical training events and technology transfer in the domain of the operation; execution of the water quality monitoring program to support development of the simulation model for the two bays. The scope of the water-quality monitoring program previously planned by CONAMA and included in the budget for counterpart costs is presented in Annex III.

- 3.43 The CONAMA team appointed by the beneficiary to coordinate the project will include the following staff: (i) a professional responsible for project coordination; (ii) a professional from the CONAMA Bio-Bio regional office; and (iii) a professional from the CONAMA executive board.
- 3.44 This professional team will be assisted by support staff trained in each of the project activities. These will be drawn from CONAMA professional staff who will have access to all information, in order to replicate knowledge acquired and help the institution to better address the problem of cleaning up marine water bodies in different geographic zones of the country. A professional from the Talcahuano Maritime Authority will also participate, along with professional staff assigned from CONAMA's regional offices in Atacama, Antofagasta, Coquimbo, Valparaíso, and the Lakes region.
- 3.45 **Consultative group:** This will be formed by a group of experts in physical and chemical oceanography, together with professionals that have worked on projects related to the bays, who will lend professional support to the CONAMA team. These will be mainly academics from INTEC and the Concepción University EULA Center.
- 3.46 **Support and coordination group:** This group will make it possible to give continuity to the support and cooperation policy developed in the Talcahuano Environmental Recovery Program (PRAT). The group will consist of representatives from public utilities, private enterprise and the organized community, who in the stage of preparing the PRAT action plan, raised the need for a load capacity model for the Concepción and San Vicente bays.
- 3.47 The actions of this group will facilitate the collection of data and information needed for preparing the pollution control plan.
- 3.48 **Local consulting service (monitoring of water quality in the bays):** Once the sampling plan and program have been defined (see Annex III), this consultancy will be put out to tender and awarded to a local firm that is in a position to satisfy the requirements established in the monitoring program. Responsibility for contracting this consulting service will rest with CONAMA's Bio-Bio regional office, using internal funds.
- 3.49 **International consulting firm:** The international consulting firm will be responsible for all technical inputs in the development of the simulation models and the pollution control plan. Its brief will also include field measurement tasks, sampling additional sources and anything relating to the monitoring of water quality not included in the monitoring program for which the counterpart is responsible. These tasks, to be carried out by the international consulting firm supported by local consultants contracted by it, include the following: bathymetrics; measurement of currents and meteorological parameters; profile sampling of salinity, temperature

and dissolved oxygen (DO); on-site testing to determine oxygen demand by sediments; on-site testing to determine the production and consumption of DO by phytoplankton. The international consultant's work will be supported by local consultants to be contracted directly by the international firm. The region has experts trained in oceanography, meteorology, environmental geochemistry, treatment of industrial waste and other areas. The members of the Consultative, Support, and Coordination Groups may not be hired as local consultants.

## **E. Monitoring and evaluation**

- 3.50 Monitoring and evaluation activities will be carried out throughout the project, integrated into the technology transfer and training activities. Workshops and/or working seminars are expected to be held at the end of each stage. Interim products will be analyzed and discussed by CONAMA professional staff, together with a variety of experts from the consultative and support and cooperation groups. The international consulting firm is expected to prepare eight interim reports and two final products, as per the following scheme:

**Product delivery scheme**

<b>Product</b>	<b>Month</b>
<b>Delivery of interim products:</b>	
1. Preliminary work plan	2
2. Detailed work plan	4
3. First campaign report	6
4. Model calibration report	8
5. Control plan (preliminary version)	10
6. Second campaign report	13
7. Model validation report	15
8. Control plan (final version)	17
<b>Delivery of final products:</b>	
I. Final product of modeling component	17
II. Final product of pollution control plan component	18

## **F. Costs and financing**

- 3.51 The detailed budget of the TC project shows the costs to be disbursed by the Fund and the beneficiary. The following table summarizes that budget.

**Table of costs in US\$**

<b>Item</b>	<b>JCF</b>	<b>Counterpart</b>	<b>Total</b>
1. Staff	694,050	34,993	729,043
2. Materials and services (*)		166,696	263,696
3. Seminars, workshops and administrative costs	97,000	32,585	32,585
4. Travel and per diem expenses	159,300	2,726	162,026
5. Overheads	237,000	18,630	255,630
6. Contingencies	12,650	3,000	15,650
<b>Total</b>	<b>1,200,000</b>	<b>240,000</b>	<b>1,440,000</b>

(\*) Laboratory analysis; rental of boat and equipment.

#### **IV. BENEFITS AND RISKS**

- 4.1 The Bank's strategy in Chile includes support for competition and productivity through the following channels: improvements to public services and technological innovation systems; an increase in social and regional equity and quality of life; modernization of public administration, encouraging partnerships with the private sector and civil society; and an increase in participation by civil society stakeholders. This technical cooperation project is consistent with the strategy since it provides the government with tools aimed at improving the quality of the environment and life in a major urban area of the country, based on applying established technology through partnerships between the public and private sectors.
- 4.2 This technical cooperation is a priority action for the Government of Chile, and its objectives are included in CONAMA's institutional goals for the second phase of the Talcahuano Environmental Recovery Program. The final product to be obtained from the operation will be an action plan to remedy the current state of pollution in the Concepción and San Vicente bays. Implementation of the plan will have a wide-ranging, significant and positive impact on water and environmental resources in the Concepción/Talcahuano metropolitan area.
- 4.3 Execution of the pollution control plan is expected to persuade industries in the area to adhere to the new timetables set for complying with the current regulations. These bring forward dates for completing treatment plants for industrial wastewater (and other waste products), thereby establishing acceptable waste disposal channels. The plan will be directly linked to the current program for improving urban wastewater disposal already established by the competent operating entities, such as the Bio-Bio regional water company (ESSBIO).
- 4.4 The risk of this project lies in the technology transfer and training component. If its activities fail to achieve their objectives, implementation of the control plan resulting from the project could be made unviable. If effective transfer of the

technology to be used and its assimilation by CONAMA professionals and regional experts does not materialize, the resultant environmental management tool will not have recognition and credibility among social and economic stakeholders and will therefore be useless. Mitigation of this risk is addressed in the operation on two fronts: the project execution mechanism itself provides for broad-based participation in the project coordination and execution structure by various local institutions and experts; and the technology transfer and training component has been given special attention and strengthening in project planning. This component, as incorporated in the technical cooperation project, should enable CONAMA to replicate knowledge acquired, and apply it to the decontamination of seawater bodies in different geographic areas of the country.

## **V. RECOMMENDATION**

- 5.1 Asunción Aguilá, chief of the RE1/EN1 Division, recommends approval of this operation and the use of up to US\$1.2 million (one million two hundred thousand dollars) drawn from the Japanese Trust Fund for Consulting Services.

(original signature)

07/29/02

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Asunción Aguilá, Chief RE1/EN1

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Date

## **VI. CERTIFICATION**

- 6.1 The undersigned hereby certifies that there are sufficient resources available in the Japanese Trust Fund for Consulting Services, to provide funding up to US\$1.2 million (one million two hundred thousand dollars) for the activities described and budgeted for in this document. The commitment and disbursement of funds corresponding to this certification, will cover remuneration and payments to consultants, other than local consultants working in their own country, who will receive their remuneration and contracted payments in the currency of that country. No JCF resources will be made available to cover amounts exceeding those officially assigned for implementation of this Operations Plan. Amounts in excess of those authorized may arise from commitments established in contracts denominated in a currency other than that of the Fund, and may result in exchange-rate differences in currency conversion, for which the Fund accepts no responsibility whatsoever.

(original signature)

07/30/02

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Takeo Shinde, RE2/FSS/JSF

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Date



## LEVELS OF WASTEWATER DISCHARGED INTO THE CONCEPCIÓN AND SAN VICENTE BAYS

The information presented here is published by CONAMA in the Management Report on the Talcahuano Environmental Recovery Program (PRAT). The data were collected by the Talcahuano Maritime Authority, and refer to measurements of liquid waste discharged into the two bays between 1995 and 1999.

The data used are the averages of annual measurements carried out on each firm, consisting of between four and nine annual samples, depending on the year, type of firm and the fishing recorded that year; measurements encompass fishing firms, fish canneries, and fish catchment landing terminals.

The information analyzed here does not include effluent discharged through sewerage pipes, nor discharges through streams and rivers.

Net effluent loads per year are presented below for the different parameters measured in each bay. The figures are separated into fishery firms, which encompass fish meal factories and fish landing terminals; and non-fishery firms, which include enterprises in various sectors, such as textiles, shipbuilding, iron and steel and chemicals.

### Concepción Bay

The pollution load analyzed corresponds to effluents from the 18 collector pipelines that discharge their waste into Concepción Bay, 16 of which relate to fishery firms and two others to non-fishery firms, specifically from the textile sector located in Tomé.

**Net discharges into Concepción Bay by fishery firms between  
1995 and 1999 (\*)**

Year	COD (kg/h)	G y A (kg/h)	S.S. (kg/h)	P (kg/h)	NH <sub>4</sub> (kg/h)
1995	36,519	8,970	25,737	n.a.	n.a.
1996	28,950	3,604	10,970	n.a.	n.a.
1997	30,373	4,448	13,913	n.a.	n.a.
1998	29,988	4,781	11,267	200	710
1999	8,593	993	2,750	48	440

n.a. : Information not available.

(\*): Information provided by the Talcahuano Maritime Authority.

**Net discharges into Concepción Bay by non-fishery firms between  
1995 and 1999 (\*)**

Year	COD (kg/h)	G y A (kg/h)	S.S. (kg/h)	Zn (kg/h)	Hg (kg/h)
1995	166.2	67.2	1.67	0.035	0.0007
1996	22.2	0.62	1.87	0.038	0.0000
1997	33.8	1.32	3.32	0.009	n.a.
1998	n.a.	0.56	3.18	n.a.	0.0115
1999	n.a.	0.26	0.75	n.a.	0.0078

n.a.: Information not available.

(\*): Information provided by the Talcahuano Maritime Authority.

## San Vicente Bay

In San Vicente Bay there are 14 collectors with fishery firms discharging their waste into them, nine of these are fish landing terminals. There are also eight non-fishery firms that discharge their liquid waste into the bay, using nine collector pipes. These include shipbuilding yards, iron and steel/metal engineering industries and petrochemicals.

**Net discharges into San Vicente Bay by fishery firms between  
1995 and 1999 (\*)**

Year	COD (kg/h)	G Y A (kg/h)	S.S. (kg/h)	P (kg/h)	NH <sub>4</sub> (kg/h)
1995	40,421	8,433	18,107	n.a.	n.a.
1996	43,248	10,467	17,709	n.a.	n.a.
1997	17,948	2,379	6,697	n.a.	n.a.
1998	29,236	3,654	10,209	227	1,295
1999	56,544	10,631	33,427	207	820

n.a.: Information not available.

(\*): Information provided by the Talcahuano Maritime Authority.

**Net discharges into San Vicente Bay by non-fishery firms between 1995 and 1999 (\*)**

Year	H.C. (kg/h)	S.S (kg/h)	S.T. (kg/h)	Cr (kg/h)	Zn (kg/h)	Pb (kg/h)	Deterg. (kg/h)	Fe (kg/h)	Cu (kg/h)	G y A (kg/h)
1995	111.50	36.8	930.1	0.171	0.110	0.029	0.030	0.692	0.042	22.25
1996	907.40	124.3	1022.4	0.009	0.750	0.011	0.271	1.832	n.a.	93.33
1997	0.36	4.76	201.8	0.224	0.056	0.000	n.a.	n.a.	n.a.	n.a.
1998	3.50	171.3	n.a.	n.a.	1.870	0.166	0.100	8.164	n.a.	18.14
1999	4.39	104.1	n.a.	n.a.	1.032	0.249	n.a.	2.200	n.a.	7.60

n.a. : Information not available.

(\*): Information provided by the Talcahuano Maritime Authority.

## DETAILED TIMETABLE OF TECHNICAL COOPERATION PROJECT

Stages and activities	Year																	
	2003					2004												2005
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
<b>1. Definition of detailed work plan</b>	1																	
• Collection of background information	■																	
• Preparation of preliminary work plan (monitoring, simulation and control strategies)	■	◆ 1																
• Discussion of preliminary plan (work seminar)		■																
• Preparation of detailed work plan			◆ 2															
<b>2. Development of simulation model</b>																		
• Collection of background information and specification of models			■	■														
• Program of the measurement, monitoring and sampling of additional sources					■	◆ 3						■	◆ 6					
• Model calibration							■	◆ 4										
• Model validation													■	◆ 7				
• Final product of modeling component														■			◆ I	
<b>3. Development of control plan</b>																		
• Investigation of pollution sources					■	■												
• Simulation of current situation and load capacity							■	■										
• Analysis of control alternatives								■	■	◆ 5								
• Discussion of preliminary control plan (work seminar)									■									
• Finalization of control plan															■	◆ 8		
• Seminar to present final control plan																	■	
• Final product of control plan component																		◆ II
<b>4. Technology transfer and training</b>																		
• Training and hands-on practice	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
• Training course on hydrodynamic modeling and water quality		■	■															
• Working seminars		■								■	■						■	
• Workshops		■		■	■	■	■			■	■			■		■		

◆ Delivery of partial products

◆ Delivery of final products

(see product list)

## WATER QUALITY MONITORING PROGRAM

### Preliminary version

The sampling plan involves running two intensive campaigns lasting seven days each, one in winter and the other in summertime, supported by weekly monitoring campaigns. The latter will be organized in two series of five consecutive weeks, distributed over the winter and summer periods.

Activities	Campaigns	
	Intensive	Weekly
Number of campaigns	2 (1 winter, 1 summer)	10 (5 winter, 5 summer)
Days per campaign	7	1
Sampling of water column		
• Sampling points	Concepción Bay: 4	Concepción Bay: 6
	San Vicente Bay: 4	San Vicente Bay: 6
• Vertical points	Concepción: 4 (stratification of the bay)	Concepción Bay: 4 (stratification of the bay)
	San Vicente Bay: 3	San Vicente Bay: 3
Sediment sampling	Yes	No
• Sampling points	Concepción Bay: 6	Not applicable
	San Vicente Bay: 6	Not applicable
Parameters for monitoring water column	<ul style="list-style-type: none"> <li>Nutrients</li> <li>Coliforms (fecal and/or total)</li> <li>Chlorophyl a</li> <li>COD</li> <li>BOD<sub>5</sub></li> <li>DO</li> <li>Salinity</li> <li>Turbidity</li> </ul> (Temperature and depth of Secchi Disk will be measured in the zone before samples are taken)	<ul style="list-style-type: none"> <li>Nutrients</li> <li>Coliforms (fecal and/or total)</li> <li>Chlorophyl a</li> <li>COD</li> <li>BOD<sub>5</sub></li> <li>DO</li> <li>Salinity</li> <li>Turbidity</li> <li>Loose solids (fixed and volatile) *</li> <li>Sedimentable solids (fixed and volatile) *</li> </ul> (*) These parameters will be monitored at three of the six points defined for each bay
Parameters for sediment monitoring	<ul style="list-style-type: none"> <li>Metals</li> <li>Organic material</li> <li>Benthic organisms</li> </ul>	Not carried out